Development of Geo-Concentrated & Continuous Areas with Special Difficulties in Western China: Comprehensive Evaluation and Regional Division

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***Abstract*—Western China Development promoted a rapid growth of regional economy, but also brought obvious contradictions: Western China is still lagging behind with significant disparities in internal development. Some areas, moreover, with seriously deep poverty, low standard public service and hostile living environment, is in special difficulty. This paper evaluates 171 prefecture-level cities with Improved Entropy Method to identify the significant disparities of Western China. According to geo-spatial coherence and consistent factor to poverty, this paper divides areas with special-difficulties into seven concentrated & continuous parts. And put forward some general methods to develop concentrated & continuous areas with special difficulties.**

Keywords- Western China, Special Difficulty, Improved Entropy Method, Comprehensive Evaluation, Geo-Concentrated & Continuous, Regional Division

I. INTRODUCTION

Western China Development promoted a rapid growth of regional economy[1,2], but also brought obvious contradictions due to the planning that taking economic construction as the central task [2-4]. Western China, compared with the whole nation, is still lagging behind with significant disparities in living standard and interior regional development [2,5,6]. Regional Economic Theory reveals that, regional balanced development inversely related to the growth rate in a certain period [7].Spatial Organization Theory reveals that different strategies would cause the development between state and local varies disparately [1]. Empirical research focused on two aspects, one is regional disparities between Western China and the east [1,2,4,8,9], the other is factors of poverty in the west[10-12]. Studies have pointed out that sustainable development capacity is quite low [11,12], and fragile ecological environment is main factors that caused poverty in Western China [13-16]. Some areas, moreover, with seriously deep poverty, low standard public service and hostile living environment, is in special difficulty. However, research and evaluation are still insufficient. Most studies analyzed these disparities from provincial level, lack small scale comparative studies [6,17-19]. Secondly, most studies focus on "ecological poverty" and "resources and environmental constraints", lack comprehensive evaluation. Thirdly, confined to the whole west are laggard, lack regional division and identification. This paper evaluates 171 prefecture-level cities with improved entropy method, and identifies Geo-Concentrated & Continuous Areas with Special Difficulties in Western China.

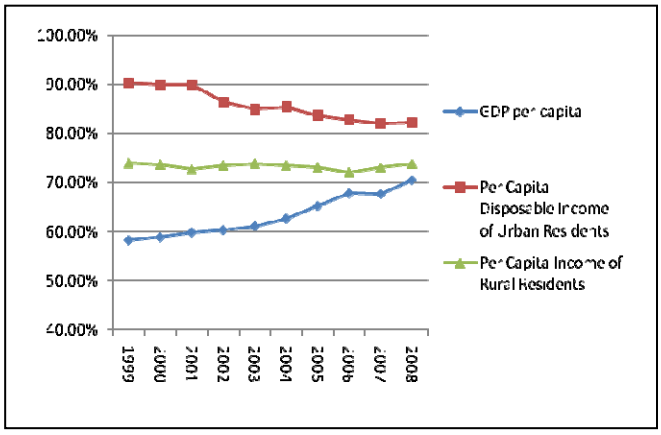

Figure 1. Per capita index of Western China compared with the state, 1999-2008

Resource : From China Statistical Yearbook 2000-2009 and Statistical Yearbook 2000-2009 of 12 provinces of Western China.

II. DATA AND METHOD

A. Data Resource

This study take 171 prefecture-level cities (countries of Chongqing municipality directly under the Central Government, the same below) as the object, most selected data

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are derived statistics though Statistical Year Book 2009 of western provinces(autonomous regions and municipalities). Elevation and Gradient are selected from SRTM DEM data with 90m resolution. Desertification is selected from 2008 LUCC 1km grid database.

Three components can be drawn from principal component analysis. And all index can be divided into 3 fields (Table I). Because of the difference of northwest and southwest in natural environment, moreover, this paper takes the standardized data of gradient and desertification. And out of which the larger is selected as the index.

B. *Inproved Entropy Method*

Entropy Method is an objective evaluation method which can determine weights of indexes. This method, as is known, is based on the degree of each index or information provided by indexed to determine weight system [20]. When confronting some special statistical data, however, it is hard to evaluate the economic result with Entropy Method. Usually, thus, researchers use standardized data to improve this method [20,21], which, more reasonable in application, is Implied Entropy Method (IEM).

TABLE I. INDEX OF DEVELOPMENT SYSTEM OF PREFECTURE-LEVEL CITIES, WESTERN CHINA

System Field	No.	Index	Unit	Direction
Economic Growth and National Lives	1	GDP Per Capita	Yuan	Positive
	2	Disposable Income of Urban Residents Per Capita	Yuan	Positive
	3	Income of Rural Residents Per Capita	Yuan	Positive
	4	Per capita Revenue	10 thousand Yuan	Positive
	5	per capita retail sales	Yuan	Positive
	6	urban-rural income difference	Rural income=1	Negative
Public Service	7	Mid-School Teachers Per Capita	Person	Positive
	8	Hospital Bed Per Capita	1	Positive
	9	Highway Mileage Per Capita	Km	Positive
Natural Environment	10	Elevation(percentage of area that> 3000m)	%	Negative
	11	Gradient(percentage of area that>25°)/ Desertification（percentage of desertification area）	%	Negative

C. *Method Steps*

The specific equations of the method are as follows:

(1) in order to eliminate the inconsistency of dimension, this paper standardize all source data by 0-1 standardized method to get xij, set $x_{ij}^{'} = (x_{ij} - \bar{x}_j) / \sigma_j$, $\bar{x}_j$ is mean of index j, σ_j is standard deviation of index j.

(2) Translate coordination to eliminate negative value, set $x_{ij}^{''} = 10 + x_{ij}^{'}$.

(3) Use formula $R_{ij} = x_{ij}^{''} / \sum_{i=1}^{m} x_{ij}^{''}$ to get weight of $x_{ij}^{''}$.

(4) Use formula $e_j = -(1/\ln m)\sum_{i=1}^{m} R_{ij} \ln R_{ij}$ where $e_j \in [0,1]$, to get entropy of index j.

(5) Use formula $g_j = 1 - e_j$ to calculate diverse coefficient of index j.

(6) Calculate weight of indicator x_j, $\omega_j = g_j / \sum_{j=1}^{n} g_j$ where j=1,2,3…,n.

(7) Use formula $V_i = \sum_{j=1}^{n} \omega_j R_{ij}$ to calculate the development results of location i.

III. RESULTS AND ANALYSIS

A. *Comprehensive Development Results*

We can get weight results of indexes according to the IEM calculation (Table II). And can get, further, composite development results of 171 prefecture-level cities by formula (7). By sequencing the results order, then, we can identify the disparities of Western China (not list here since the data more). The minimum result is Nujiang Lisu Autonomous Prefecture, $V_{i\min}$ =0.005127, while the maximum result is Keramay, $V_{i\max}$ =0.007093.

TABLE II. WEIGHT RESULTS OF INDEXES IN IEM DEVELOPMENT SYSTEM, WESTERN CHINA

Field	No.	Index	Weight (%)
Economic Growth and National Lives	1	GDP Per Capita	8.45
	2	Disposable Income of Urban Residents Per Capita	9.22
	3	Income of Rural Residents Per Capita	9.03
	4	Per capita Revenue	8.22
	5	per capita retail sales	8.31
	6	urban-rural income difference	9.27
Public Service	7	Mid-School Teachers Per Capita	8.98
	8	Hospital Bed Per Capita	8.59
	9	Highway Mileage Per Capita	7.98
Natural Environment	10	Elevation(percentage of area that> 3000m)	9.99
	11	Gradient(percentage of area that>25°)/ desertification（ percentage of desertification area）	11.96

B. Data Characteristics and Extraction of Regions with Special Difficulties

This paper use formula $V_i^{'} = V_i \times 100$ to take the relative value of evaluation results for the number of evaluation results is small. And put $V_i^{'}$ corresponding to regions on the coordinate system to fit curve (Figure 2). The formula is $y = 8\mathrm{E}^{-7}x^3 - 0.0002x^2 + 0.0141x + 5.2734$, with a related coefficient $R^2 = 0.97$. From this curve, with an "S" form, we can identify there is less developed areas, medium developed areas and developed areas in the West. This curve, moreover, can be treated as the combination of a convex function, a liner function and a concave function approximately. The liner function, in addition, can be treated as a horizontal one for the gradient is small.

Calculating the first derivative of the curve and we get $y^{'} = 24\mathrm{E}^{-7}x^2 - 0.0004x + 0.015$. When $y^{'} = 0$, the rounded endpoints of the liner function are 56 and 110. The liner function, however, is monotonic increasing approximately, so the interval of definition is larger than [56,110]. Here we take [50,116] approximately. And we take the first 50 prefectures as regions with special difficulties.

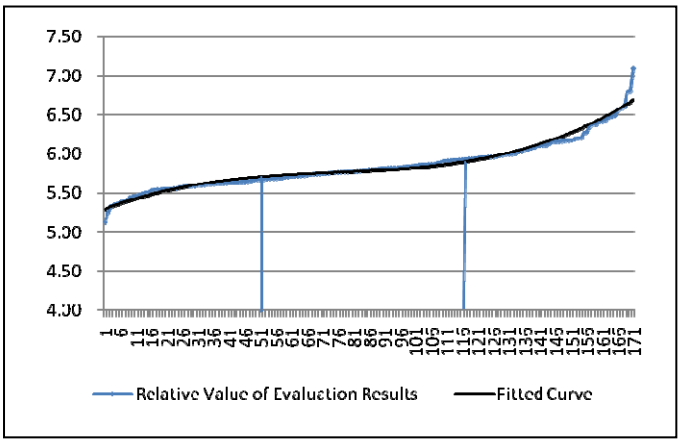

Figure 2. Relative Value of Evaluation Results and Its Fitting

IV. REGIONAL DIVISION OF CONCENTRATED & CONTINUOUS AREAS WITH SPECIAL DIFFICULTIES

A. Regional Division

In accordance with the principles of geo-spatial coherence and natural division, these 50 prefectures (counties) can be divided into seven geo-concentrated & continuous areas, as shown in Table III, named Geo-Concentrated & Continuous Areas with Special Difficulties in Western China (GCCASD).

TABLE III. DIVISION OF GCCASD IN WESTERN CHINA

Name	Province	Including Cities	No.	Name	Province	Including Cities	No.
QinBa-Liupan Mountain	Gansu	Linxia*	11	Wuling Mountain Area	Wuling Mountain Area	Pengshui*	39
		Longnan	21			Xiushan*	47
		Dingxi	26	Eastern Margin of Qinghai-Tibet Plateau Area	Sichuan	Ganzi*	2
		Tianshui	34			Aba*	7
		Qingyang	50			Ya'an	44
	Shanxi	Shangluo	48		Qinghai	Diqing*	4
		Ankang	49			Huangnan*	10
	Chongqing	Wuxi	14			Hainan*	33
		Wushan	20			Haibei*	41

		Chengkou	25			Haidong	43
		Yunyang	40		Gansu	Gannan*	6
		Fengjie	46	Qinghai-Tibet Plateau High-altitude Area	Qinghai	Yushu*	5
	Sichuang	Bazhong	31			Guoluo*	19
	Ningxia	Guyuan	38		Tibet	Changdu	3
West Yunnan Frontier Mountain Area	Yunnan	Nujiang*	1			Linzhi	9
		Lijiang	13			Naqu	18
		Lincang	17			Rikaze	30
		Puer	32			Shannan	42
		Baoshan	45	Wumeng Mountain-Upper Reaches of the Xijiang River Area	Yunnan	zhaotong	8
3 Prefectures in South Xinjiang	Xinjiang	Hetian	12			Wenshan*	16
		Kizilsu*	28		Sichuan	Liangshan*	15
		Kashi	35		Guizhou	Bijie	22
Wuling Mountain Area	Guizhou	Qiandongnan*	29			Qianxinan*	23
		Tongren	27			Anshun	36
	Chongqing	Youyang*	24			Liupanshui	37

Note:* indicates local autonomous prefecture.

B. Characteristics of GCCASD in Western China

Involving 50 prefectures, GCCASD covers 2,420,000 square kilometers, which is 35.2% of the western region (Figure 3). GDP per capita of these regions is lower than 60% of the national level, per capita rural residents income is lower than 70% while per capital urban residents disposable income is lower than 75% of national level. Of these 50 prefectures, 19 are autonomous districts. Economic development and people's living is lagging behind, but, still, there are special difficulties in GCCASDs.

Qin Bashan - Liupanshan Area is located in the hinterland of Qinling Mountain, Daba Mountain and Liupan Mountain, where there is mountainous and graben basins scatter around. Ecological poverty is an important feature here. This area is unfit for human social activities and economic development because of the unique location, topography and climatic conditions.

West Yunnan Frontier Mountain Area is the core area of "Three Parallel Rivers", where there are towering mountains, deeply cutting valleys and strong geological movements. Most of this area is unfit for human social activities because of geology, topography, climate, hydrology and other factors. Meanwhile, this is a multi-ethnic living area with low education level and low population quality. Some place, even, still remain primitive.

Wuling Mountain Area, located in the east of Yunnan-Guizhou Plateau, covers the majority of the hinterland of Wuling Mountain. The geographic and geomorphic condition here is mountainous all around with karst landform in part of this region. Thus, economic development is limited by the adverse natural environment. This region is also multi-ethnic living area.

Wumeng Mountain- Upper Reaches of the Xijiang River Area is another typical mountainous terrain with serious stony desertification and barren land all around. And most of here is karst landform. With the expansion of urbanization, the groundwater drops sharply, which caused increasing collapse of surface. Regional drinking difficulty issues often occur. Poverty is widespread in the region, and absolute poverty is significant.

Three Prefectures in South Xinjiang locates among Tianshan Mountain, Kunlun Mountain and Taklimakan Desert. This area, far away from inland China, is with Gobi desert all around but only small part of oasis for living. Most of the population here is Uyghur and Khalkhas. Local social activities and economic development also limited by language, culture, education level, which is full of special difficulties.

Eastern Margin of Qinghai-Tibet Plateau Area is transitional region of the second step ladder in topography to the third one. It is also the origin of three rivers, and most of which is prohibited zone. This is also a multi-ethnic area.

Qinghai-Tibet Plateau High-altitude Area is the origin of Yangtze River and Lancang River, most areas are restricted zones, some even prohibited zone. It covers most of the third step ladder, which is over 4000 meters in elevation. It is an anoxic, cold and ecological fragile area and is not suitable for extensive social and economic activities.

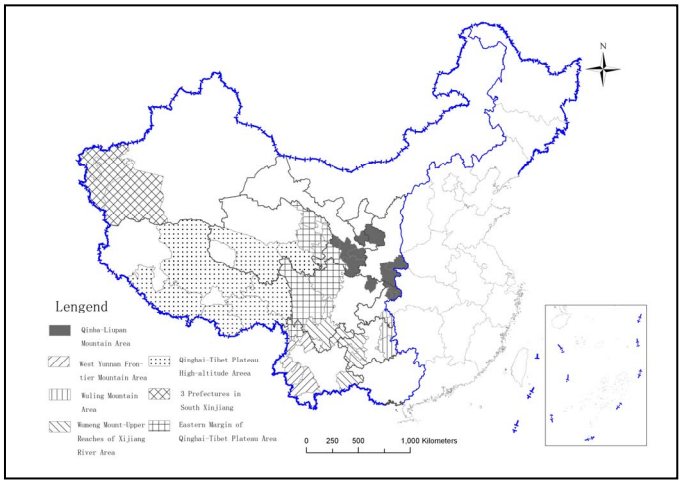

Figure 3. Spatial Distributions of 7 GCCASD

V. CONCLUSION AND DISCUSSION

Through assessment and analysis, we know that there is dramatic divergence in Western China. The results of IEM show us three parts: less developed areas, medium developed areas and developed areas. Especially, the less developed areas can be divided into 7 Concentrated & Continuous Areas with Special Difficulties, which, each one is with specific difficulties as expounded.

Some foreign ideas are worthy, on developing less developed regions. In developing the West, the US government focused on infrastructure and public construction, the preferential supply of land resources as a means of investment, environmental management and conservation, as well as the layout of high-tech initiatives such as the military industry, aircraft industry [1]. While Europe carried out regional governance to promote developing the backwards [22-24]. What is mentionable is that improving people's livelihood has been formulated as core task in the next decade in Western China Development, and improving the development of regions with special difficulties in one important step in the further [25].

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